Volume 32 June, 1946 *Number 6*

Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

PETROLEUM
ASPHALT

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TEXACO PETROLEUM PRODUCTS

Research

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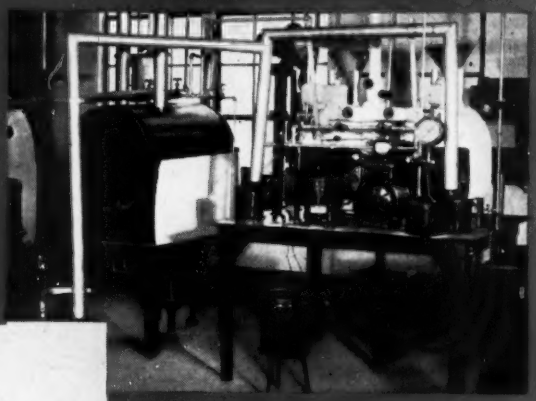
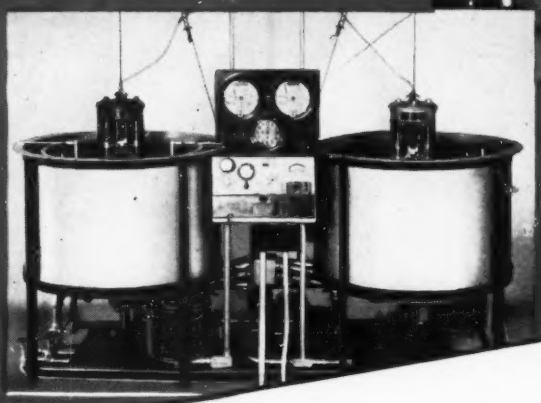


A Few of the Experimental Laboratory Asphalt Stills and Converters



Twin Machines for Testing Weathering Properties of Roofing Asphalts

THERE are hundreds of Texaco asphalt products for a multitude of uses.

Constant research is a prime reason why all of them are always top quality for whatever purpose they are desired.

A staff of technologists and complete laboratory facilities are available to help you solve any problem involving the use of asphalt . . . including the development of new asphalt products to meet special requirements.

TEXACO

THE TEXAS COMPANY

LUBRICATION

A TECHNICAL PUBLICATION DEVOTED TO THE SELECTION AND USE OF LUBRICANTS

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PETROLEUM ASPHALT

ORIGIN OF ASPHALT

Asphalt is the heavy, black, cementitious material which is derived from the naphthenic or "asphaltic" component of petroleum. Petroleum is a complex mixture of hydrocarbons formed from organic materials such as marine plants which have undergone decomposition usually under pressure of super-imposed layers of silt, sand and rock several thousand feet below the earth's surface. Such deposits originated at least as far back as the Tertiary Age, more than 100,000 years ago. Some of these deposits later were brought near the earth's surface by upheavals of the land and sea.

That was the source of the asphaltic materials which were found by the ancients and used as early as 3200 BC. Their ingenuity put it to use for pavements, baths, irrigation systems and sealing of tombs. Excavations reveal that asphalt was applied in those days as a cementing medium in structures which have withstood the ravages of time to the present day. It is the most useful and widely available waterproofing and cementing material available to man.

The outcroppings of asphalt used by the ancients were the result of natural separation of the asphalt from lighter constituents of petroleum. During this process such asphalt frequently became more or less mixed with fine mineral matter. Asphalt occurring in this manner is termed natural asphalt since it has been "refined" by nature. Deposits of various consistencies or hardness running from essentially pure hydrocarbons to low grade sand asphalts containing down to 6% asphalt are still used and occur in scattered spots in various parts of the world. These deposits are so variable that they must usually be mixed with refined petroleum asphalt in order to obtain a product of suitable consistency for commercial uses.

PETROLEUM products, to many people, mean gasoline and motor oil. There is usually no conception of the expanse of the Petroleum Industry beyond their favorite service station or their preferred radio program. Yet they ride on olive under another petroleum product — asphalt — without which modern travel and home security would be seriously restricted.

We feel they would like to know more about asphalt; its origin; its place as a component of petroleum oil; how ancient civilization made use of it; how it is used today. This article highlights the story of petroleum asphalt.

SOURCES OF PETROLEUM ASPHALT

Refined petroleum asphalts are obtained from selected crude oils under controlled refining procedures which produce grades most suitable for each purpose. During the processing, any mineral matter or water coming from the wells is settled out, and the light hydrocarbon components in the crude are distilled off to be used as gasoline, kerosine and lubricating oils. The resulting asphalts are pure hydrocarbons meeting exact specifications desired for each grade.

Crude oils vary widely in their suitability for use in manufacturing asphalt. It has been found that

paraffin base oils containing hydrocarbons in which the molecules consist of essentially straight chains of carbon atoms with their associated hydrogen atoms, are not suitable for asphalt manufacture. They are, however, excellent sources of lubricating oils, paraffin wax and heavy cylinder oils. Oils in which the complex molecules of hydrocarbons are not arranged in a chain but are in groups of rings (naphthenic oils) are suitable for asphalt and the crudes of this type are carefully selected for this purpose by refiners of petroleum. This type of crude oil may also be subdivided into further classifications depending upon the type of asphalt for which it is most suitable. This practice is followed when the best product for the purpose is to be prepared.

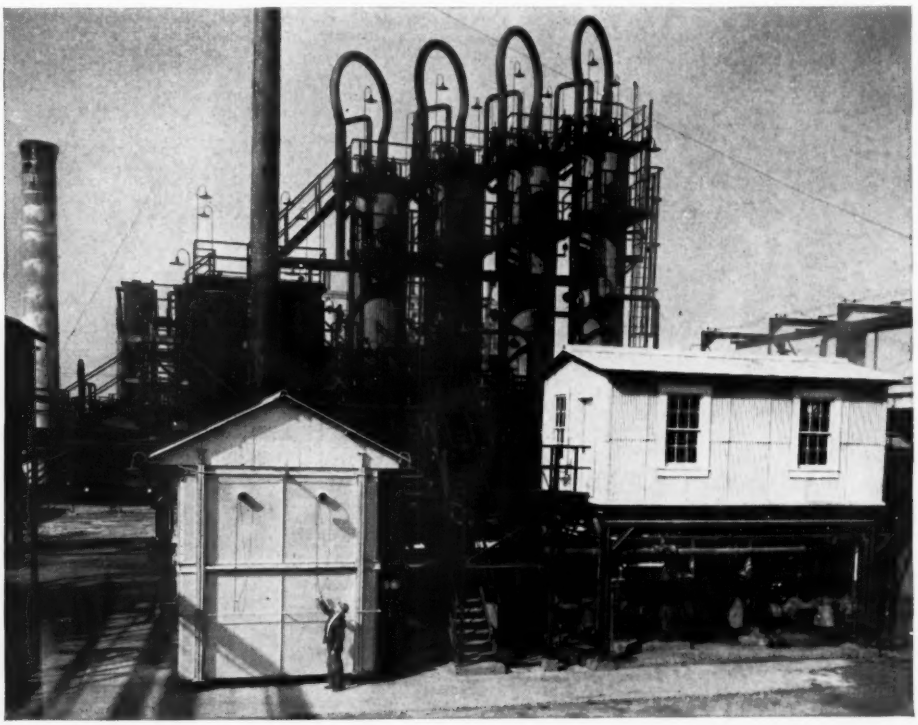

Figure 1—A battery of oxidizing units used in the manufacture of Texaco Asphalt at The Texas Company's Port Neches, Texas, Refinery. Here air is blown through the asphalt to produce a wide variety of industrial products

REFINING OF PETROLEUM ASPHALTS

Having selected the crude oils for refining to asphalt, the next process is distillation. This consists of boiling off the light and medium fractions from the crude by application of heat alone for the light fractions, such as gasoline and kerosine, and by heat and steam for the heavier oils. Vacuum is also used to lower the boiling point of the heavy oils and enable their removal at a temperature such that the resulting asphalt is not harmed. Excessive heating will decompose or "crack" the asphalt.

The process of distillation may be carried out in ordinary horizontal shell stills either by batch treatment or by continuously pumping crude into one still from which gasoline is distilled, allowing the balance to flow to the next still from which kerosine is removed, etc. Modern equipment, however, involves a so-called tube still in which a continuous flow of crude is pumped through a series of tubes, which are heated by direct fire in a furnace. Sufficient heat is supplied so that vaporization takes place all at once when the oil leaves the tubes. The products are then separated from each other by a series of condensers which condense the high boiling products first and the light ones last, (such as gasoline) at the coolest condenser. These distillation processes are controlled by the rate of flow, temperature, etc., so that each fraction meets the desired tests. The heavy material remaining in the still may be either asphalt of the required consistency or a product which must be processed further to the desired characteristics.

Asphalt that is finished by distillation alone is called "steam reduced". Many crude oils, however, do not yield asphalts suitable for use by distillation alone. The residue from distillation of some crudes

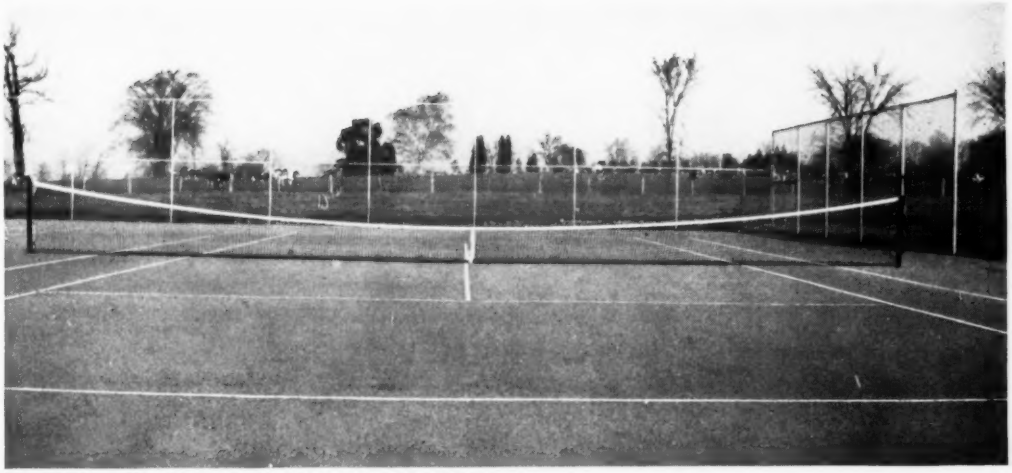

Figure 2—Asphalt tennis courts are non-skid, resilient.

requires oxidation in order to obtain useful asphalts. This is carried out by passing finely divided air through the material in a still or "converter" at a controlled elevated temperature. The resultant products are called "air blown" asphalts.

Solid and semi-solid asphalts obtained from these two processes cover the entire range of consistency and softening point according to their intended use. A few typical grades are shown in Table I, page 60.

There are two additional sources of petroleum asphalts other than the above which yield products for special purposes.

i.e.

(a) From thermal cracking of gas oils to produce gasoline: An asphaltic residue which somewhat resembles a tar is obtained from this process. This product is not as weather resistant as asphalt obtained from the steam reduction of good quality crude oils, but is valuable as a briquette binder and as a slow curing liquid asphalt for secondary earth and gravel roads.

(b) From the solvent refining of lubricating oils: Recent improvements in lubricating oils have been accomplished by solvents which separate the naphthenic type of molecule from the paraffinic even though both may boil at the same temperature and therefore cannot be separated by distillation.

The heaviest portions of such extracts removed from some lubricating oils are excellent sources of asphalts for specific industrial purposes; they furnish useful blending stocks for producing asphalts with high ductility. The re-

Figure 3—Plant mix pavement being laid by mechanical spreading machine.

TABLE I

TESTS ON TYPICAL ASPHALTS

	PAVING		*ROOFING*					
Use	*Penetration Macadam*	*Asphaltic Concrete*	*Shingle Saturant*	*Shingle Coating*	*Built-Up Roof Mopping*	*FLOORING SATURANT*	*WATER-PROOFING*	*MINERAL RUBBER*
Softening Pt., B&R, °F.	112	129	146	226	190	157	151	302
Ductility at 77°F., cm	60+	100+	100	2.0	2.0	12	22	0
Penetration at 32°F.	40	25	13	12	14	8	10	2
Penetration at 77°F.	135	64	33	18	30	20	27	4
Penetration at 115°F.	Soft	249	108	31	65	67	92	8
Evaporation (50gms-5 hrs.—325°F.) %	0.01	0.06	0.03	0.01	0.01	0.0	0.0	0.02
Flash, C.O.C., °F.	550	540	560	570	560	645	600	635
Solubility in $CC1_4$, %	99.8	99.8	99.8	99.7	99.8	99.8	99.8	99.8

Ductility: Centimeters stretch in a mold having a cross section of 1 sq. cm. before breaking.

Penetration: A standard asphalt needle is forced into the surface and the penetration is the distance in 0.10 mm. under each condition of test.

32°F.:	200 gms.	60 seconds
77°F.:	100 gms.	5 seconds
115°F.:	50 gms.	5 seconds

Solubility in $CC1_4$: indicates purity.

verse process, that is solvent refining of an asphalt residuum, is not practical since the lubricating oil yield is not sufficient or of high enough quality to justify the cost.

In addition to making solid and semi-solid asphalts as such, many refiners also supply various types of liquid asphalts prepared either by the addition of a solvent or by emulsification. Either procedure provides asphalt to users in a form which can be used cold whereas straight asphalt always requires heating by the consumer.

USES OF ASPHALT

Asphalt is one of the most versatile materials obtained from petroleum. In one form or another it enters into our daily life and makes living more comfortable. Rarely do we take an automobile out of the garage without driving over an asphalt road.

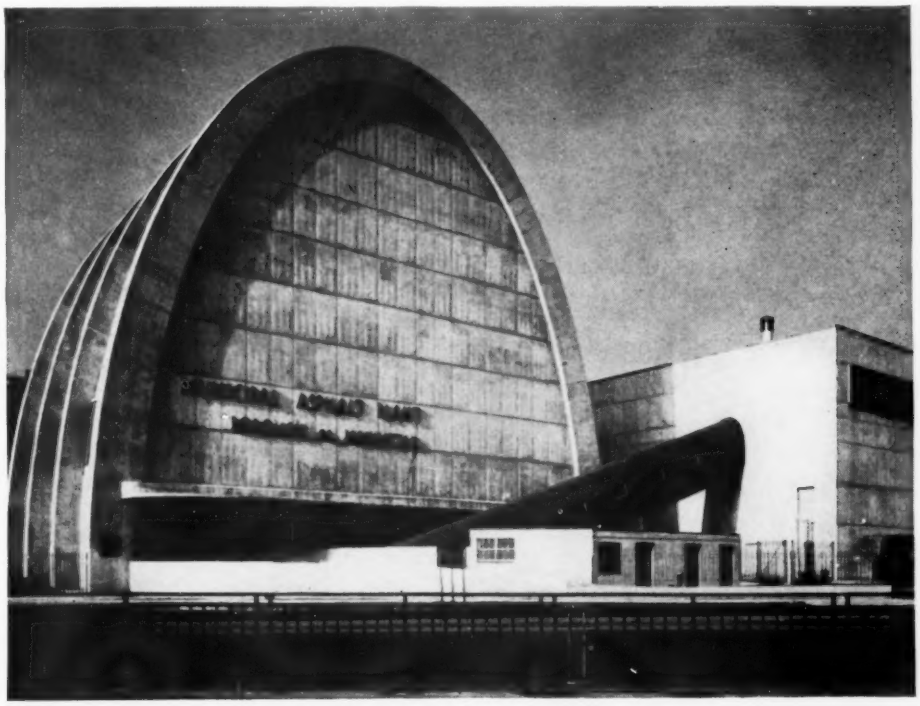

Figure 4—Modern hot asphalt paving plant, New York City.

Probably the garage is covered with an asphalt roof of some type. The battery in our car is probably made of an asphalt composition and even the tires contain asphalt used as a plasticizer by the rubber compounder.

Over half of the asphalt produced in the U. S. is used for roads and pavements. About 25 to 30% is used for roofs and the balance for a large number of purposes such as the following:

Waterproofing	Floor covering
Paint	Crack and joint filler
Fuel briquettes	Insulating Compounds and boards
Weatherproof wire	Underground cables and pipe
Battery boxes	Revetments
Railway ballast	Cements
Rubber products	Rustproof compounds
Brake linings	
Playgrounds	

Since paving and roofing constitute the major uses of asphalt from the standpoint of tonnage, a description of these industries is of interest.

Paving

Asphalt roads and pavements are built by two general methods:

(a) By laying a mixture of mineral aggregate and asphalt previously prepared in a plant.

(b) By application of asphalt in liquid state directly to the road surface usually by means of a distributor.

Asphalt for high type heavy duty pavements such as those used in cities is mixed hot in large stationary plants. The mixtures are delivered to the job hot, spread either by hand raking or by machine and rolled while still hot. Asphalts having consistencies between 40 and 150 penetration are used for this purpose, depending upon climate, amount of traffic and aggregate gradations. The latter vary

Figure 5—Laying asphalt ballast at railroad station.

according to local supplies and the type of surface desired. So-called sheet asphalt which is widely used as a top course in city streets is a mixture of asphalt, sand and filler. Asphaltic concrete contains asphalt, graded stone, filler and usually some sand. Base courses used underneath wearing courses are usually mixtures of stone, sand, and asphalt. Typical mixtures for hot laid pavement courses are as follows:

	Base Course	*Asphaltic Concrete*	*Sheet Asphalt*
2" Stone—%	45	—	—
1" Stone—%	20	20	—
½"-¼" Stone—%	10	30	—
Fines—%	20	38	75
Dust—%	None	5	15
Asphalt—%	5	7	10

Hot plant mixtures are also frequently used for highway construction in the country in which case the mix may either be delivered from a permanent plant or a portable plant may be set up near the site convenient to sources of material. The principal consideration is distance since hot mixtures cannot be delivered in condition to lay at jobs too far away from the mixing plant, even though insulated trucks are sometimes used.

Mixing plants are also used for cold mixes, in which either emulsified asphalt or cutback asphalt is used. In these cases the road does not attain stability sufficient to withstand traffic until the water or solvent used to liquefy the asphalt has evaporated and the pavement is "cured".

Cold mixtures are not as limited in regard to the time between mixing and laying and are therefore suitable for either hauling long distances or even stock piling. They also can be made right on the road by travelling plants which pick up the pre-

Figure 6—Traveling asphalt paving plant in operation.

Figure 7—Distributor applying Asphalt to a 3-inch Asphalt Penetration Macadam base for an airport runway.

pared dry aggregate from a windrow at one end of the machine, mix it with liquid cutback asphalt or emulsion and deliver it back to the road at the other end of the machine as it travels along. Typical liquid asphaltic materials used for this type of construction are shown in Table II, page 64.

The other method of using asphalts on highways, namely, direct spraying of the material on the road by means of a distributor, is practiced with three different procedures:

(1) *Surface Treatment*

When used as a primer, for sealing or construction of carpet coats. This technique is usually used only over old surfaces which present a dust free dense surface to which the liquid asphalt can adhere. The application is followed by a uniform quantity of aggregate which embeds itself in the asphalt, thereby forming a new riding surface. The asphalt also seals cracks in the old pavement and

Figure 8—Mixing aggregate and liquid asphalt with a road grader.

waterproofs the surface. Only the lightest materials are used as primers to be followed by a heavier treatment. Soft asphalts (usually above 150 penetration), liquid surfacing materials and emulsions are all useful for this type of work usually on secondary roads carrying light traffic.

(2) *Penetration Construction*

Aggregate which is graded sufficiently open to permit penetration of the asphalt into the voids is first applied in uniform thickness to the road. Asphalt is then applied in sufficient thickness to penetrate this new aggregate and a layer of smaller aggregate is applied. A second application of asphalt and fine stone is frequently used. This type of construction is sometimes followed by a surface treatment to seal the voids in the surface. Soft asphalts and the heavier grades of surfacing materials and emulsions are suitable for this type of construction.

(3) *Road Mixing*

When the asphalt is applied directly to the road in this procedure, the asphalt and aggregate are mixed on the road with a blade grader or some type of special travelling mixing and spreading machine. In this case the aggregate is usually placed on the road before the application of asphalt, sometimes in a windrow and sometimes spread out. Proportioning cannot usually be controlled as accurately as in a plant but the cost is frequently less and a mat of most any desired thickness can be obtained with graded aggregate containing fine material. The most suitable forms of asphalts for this purpose are the medium and slow curing liquid surfacing materials. A lighter grade than that used in plant mixes is usually used because it can be mixed more readily on the road.

There are several grades of liquid cutback asphaltic materials other than those shown in Table II below, varying in viscosity and asphalt content. The lightest, most fluid products are designated as No. 0 and the heaviest No. 5. Their principal uses as recommended by the Asphalt Institute are shown in Table III on page 65.

TABLE II
TESTS ON TYPICAL LIQUID ASPHALT MATERIAL

	Rapid Curing RC-3	*Medium Curing MC-3*	*Slow Curing SC-3*	*Slow Setting Emulsion SS-1*
Flash, °F. (Tag Open Cup)	90	170	230	—
Vis. Saybolt Furol at 77°F.	—	—	—	70
at 140°F.	350	350	350	—
Distillation:				
(ASTM D 402-42)				
% Distillate off				(D 244-42)
at 437°F.	28	2	—	—
500°F.	60	30	—	42
600°F.	83	75	—	—
680°F.	100	100	—	—
Residue from Distillation:				
% Asphalt	74	76	90	58
Penetration at 77°F.	100	200	Soft	150
Ductility at 77°F.	100+	100+	—	100+
Solubility in CCl_4, %	99.7	99.7	99.7	98.5
Asphalt, of 100 Pen., %	—	—	74	—

Plant Lubrication

The lubrication of an asphalt plant is important due to the usual prevalence of dust and dirt in the air. A good gear lubricant is required for gears driving the drier and mixer. A #2 grade of soda soap grease suitable for application with a hand gun is needed for all pressure fittings and an SAE 30 Oil is required for oil-lubricated motors, etc.

Roofing Manufacture

Asphalt roofing is used on more roofs in the U. S. than any other material. These roofs are of three general types:

TABLE III

RECOMMENDED USES OF LIQUID ASPHALT SURFACING MATERIAL

USE	RC Rapid Curing Grades						MC Medium Curing Grades						SC Slow Curing Grades					
	0	1	2	3	4	5	0	1	2	3	4	5	0	1	2	3	4	5
Priming																		
Tightly bonded surfaces							x											
Loosely bonded fine grained surfaces								x										
Loosely bonded coarse grained surfaces									x									
Dust Layer													x	x				
Seal and Carpet Coats																		
With or without light sand cover	x																	
Coarse sand cover		x							x	x								
Clean ¼" aggregate cover			x															
Clean ½" aggregate cover				x														
Clean ⅜" aggregate cover					x													
Clean ¾" aggregate cover						x					x	x						
Graded gravel aggregate cover									x	x					x			
Gravel mulch									x						x			
Road Mix																		
Open graded aggregate																		
Sand	x	x								x								
Max. dia. 1", high % pass. 10 mesh										x	x							
Macadam aggregate			x	x														
Dense graded aggregate																		
High % pass. 200 mesh									x						x	x		
Max. dia. 1", med. pass. 200 mesh									x	x					x	x		
Cold Patch																		
Open graded aggregate			x							x								
Dense graded aggregate									x									
Cold Laid Plant Mix																		
Open graded aggregate																		
Sand			x	x														
Max. dia. 1", high % pass. 10 mesh			x															
Macadam aggregate				x	x													
Dense graded aggregate																		
High % pass. 200 mesh										x	x						x	x
Max. dia. 1", med. % pass. 200 mesh											x	x					x	x x
Primer to be followed with soft AC							x											
Penetration Macadam (cold weather)					x													

(1) Shingles are used in residential construction because of their beauty and permanence. They are made in a wide variety of shapes and attractive colors to suit any type of architecture.

(2) Roll roofing is used on temporary buildings, sheds, barns, warehouses, etc., wherever protection is required at a minimum cost.

(3) Built-up roofing is used on relatively flat roofs of commercial buildings. This type of roof is applied by cementing layers of saturated rolls of felt to the roof with hot asphalt. It is surfaced either with a top mopping of asphalt or preferably with gravel or slag embedded into a top layer of hot asphalt.

The manufacture of these three types of roofing is basically the same.

Saturated Felt

Dry felt made on machines similar to a paper machine but from a mixture of rags, paper and wood fiber is continuously fed to the roofing machine. It passes through a saturator where it is fully impregnated with hot asphalt. This saturated felt is cooled and packaged in rolls for use on built-up roofs. It is made in two weights, the light grade containing sufficient material in a roll weighing 60 lbs. to cover 400 sq. ft. of roof one thickness. The heavy grade contains sufficient material to cover 200 sq. ft. in a roll also weighing 60 lbs.

Roll Roofing

Saturated felt is passed on through a coating and surfacing section to make roll roofing. Here a coating asphalt, usually of about 220°F. softening point, is applied to both sides and a fine surfacing of talc or mica is applied to prevent sticking in the rolls and protect the asphalt from the weather. This product is called Smooth Surfaced Roll Roofing and is normally made in weights of 45, 55 and 65# per roll of 108 sq. ft. which is sufficient to cover a roofing "square" of 100 sq. ft. including laps. Mineral Surfaced Roll Roofing is similar but colored mineral granules are substituted for the talc or mica on one side of the sheet. This product is standardized at 90# per roll.

Shingles

Shingles are made similarly to mineral surfaced roll roofing but a harder asphalt is used as a saturant to lend stiffness to the product. Instead of being rolled up the sheet is cut into shingles on a machine on which cutting rolls can be interchanged to cut a shingle of any desired size or shape. These shingles are then bundled in convenient packages for handling that contain some even fraction of the number of shingles required to cover one square of roof and so labelled. The number of square feet of material required to cover 100 sq. ft. of roof surface varies with the type of shingle, and the best grades which give the longest service contain sufficient material to give two or three thicknesses of material on the roof. There are three types that are most generally used—square butt, hexagon and reroofer, which are shown in the drawings below.

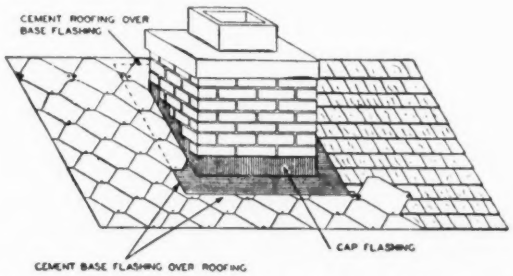

Figure 10—Reroofing shingles are largely one thickness—note flashing construction.

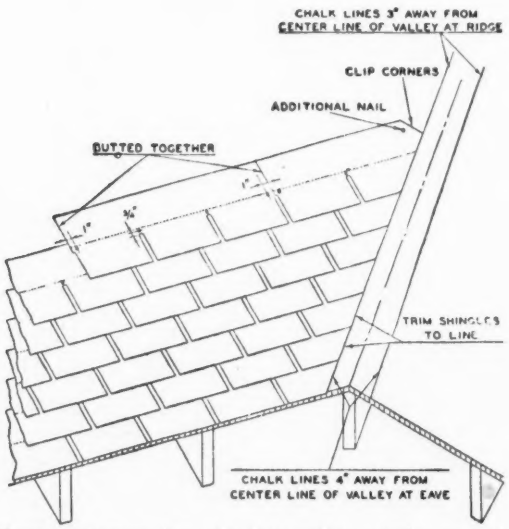
CHALK LINES 3" AWAY FROM CENTER LINE OF VALLEY AT RIDGE
CLIP CORNERS
ADDITIONAL NAIL
BUTTED TOGETHER
TRIM SHINGLES TO LINE
CHALK LINES 4" AWAY FROM CENTER LINE OF VALLEY AT EAVE

Figure 9—Showing how thick butt asphalt shingles are laid.

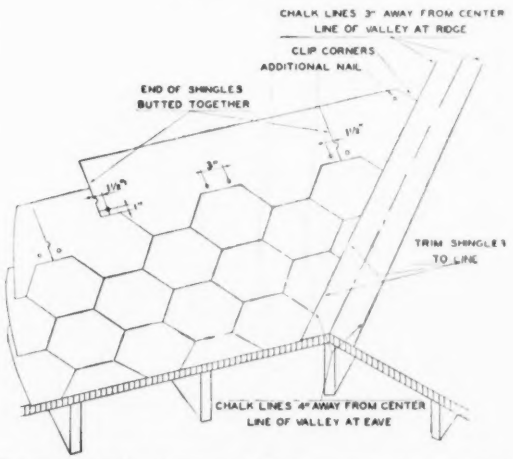
CHALK LINES 3" AWAY FROM CENTER LINE OF VALLEY AT RIDGE
CLIP CORNERS
ADDITIONAL NAIL
END OF SHINGLES BUTTED TOGETHER
TRIM SHINGLES TO LINE
CHALK LINES 4" AWAY FROM CENTER LINE OF VALLEY AT EAVE

Figure 11—Laying hexagon shingles—normally less than two thicknesses.

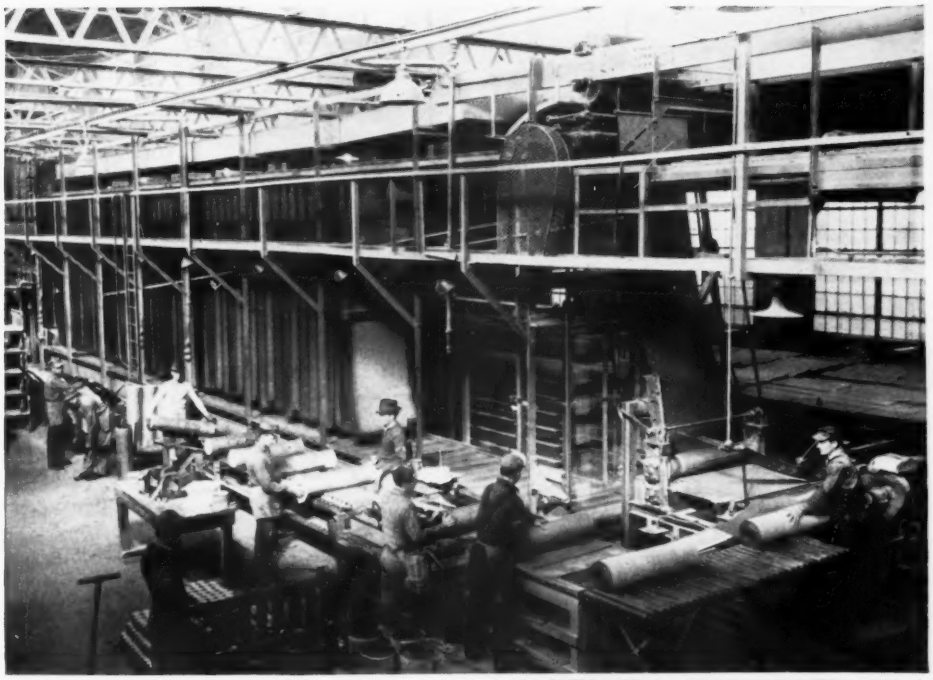

Figure 12—Finished roll roofing being taken from the end of roofing machine and prepared for shipment.

Other Uses of Asphalt

In addition to the use of asphalt for the construction of the majority of our highways and streets, large quantities are also used for sealing the joints and cracks in Portland Cement highways. The joints in brick or stone block pavements are filled with asphalt, and hard mastic blocks are made under pressure with asphalt for use on bridges, for warehouse floors, etc. Other types of floors containing asphalt are asphalt tile and the inexpensive colored roll floor covering which is frequently made on an asphalt saturated felt base.

Wherever waterproofing is necessary, asphalt is the most commonly used material. Foundations are waterproofed with a layer of asphalt frequently combined with an asphalt saturated cloth or felt applied to the outside. Swimming pools are made water tight with asphalt and even rivers and drainage ditches are frequently confined to a desired channel with an asphalt paved embankment. Large sections of the Mississippi River levees are paved with an asphalt mattress to prevent erosion. Playgrounds, tennis courts, private driveways and parking lots are made pleasant, permanent and dust free by paving with asphalt.

Many rubber products contain high melting point asphalt called mineral rubber or soft asphalt which

Figure 13—The finished job—a colorful, attractive, durable roof.

Figure 14—Launching asphalt mat. Mississippi River revetment project.

aids in plasticizing rubber compounds and bringing the various ingredients together in a homogeneous form before vulcanizing.

Cheap pulverized coal is moulded into clean, usable briquetes by cementing with asphalt. Other hard moulded products such as battery boxes and brake linings are made economically and successfully containing asphalt because it is not only a tough cement but is resistant to chemicals.

A recent development of interest is the use of asphalt for stabilizing and waterproofing railway tracks. Sections of railways that are unstable and cause rough or slow train travel due to the track becoming out of line or level can be maintained in good condition when the soil under the track is stabilized with a slurry containing asphalt-cement-sand-and water and the ballast itself is cemented together and waterproofed with asphalt.

Fortunately asphalt is available in large quantities from Petroleum in this country and the benefits that can be obtained from its use are fully realized. A total of about 6,000,000 tons are used in the U. S. annually and many more uses will probably be found for this versatile material.

Figure 15—Asphalt tile floor in modern drug store.

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New York 17, N. Y.

Asphalt Roofing...

America's Favorite 2 to 1

TWICE as many roofs are protected by asphalt as are protected by all other types of roofing combined: That's because asphalt offers the greatest economy in initial application and upkeep for weather protection . . . plus fire-resistance and long life.

Texaco Asphalt Roofing Products . . . roll roofings, solid roofing asphalt, and colorful shingles . . . are made with Texaco's own asphalt . . . 99½% pure. The Texas Company is one of the world's largest asphalt producers.

Lasting protection and attractive appearance for every type of roof are assured with Texaco Asphalt Roofing Products.

TEXACO

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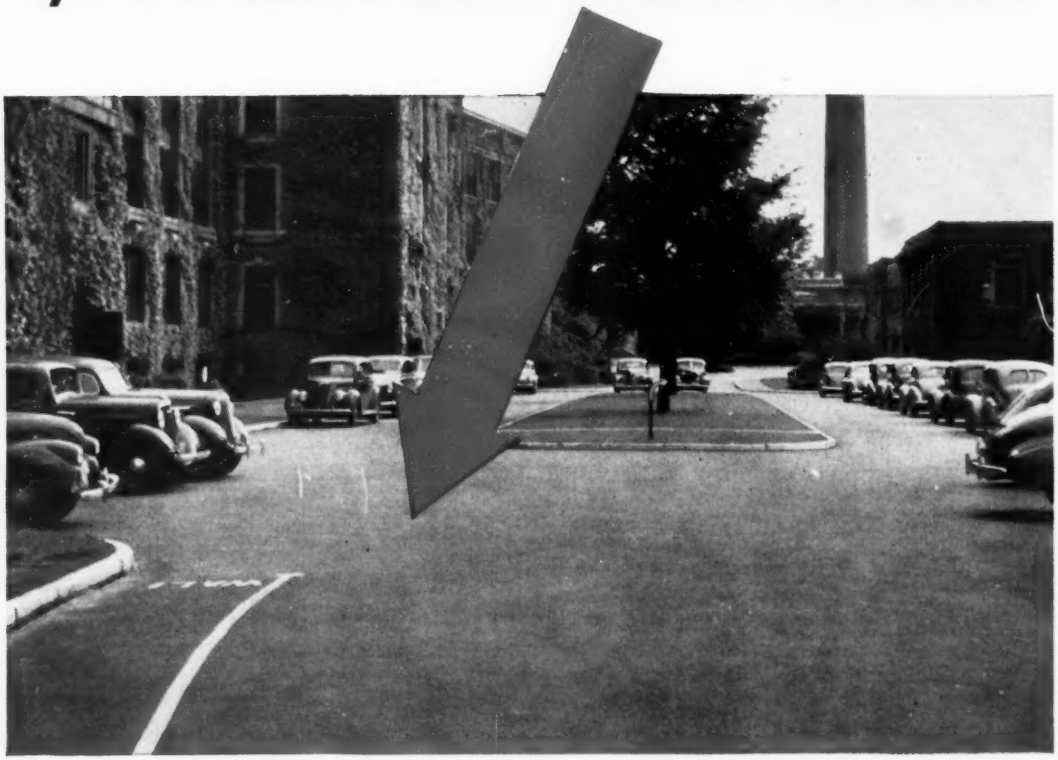
Asphalt SHINGLES and ROOFING

1,500 cities have this in common



Texaco Asphalt driveway and parking area entering a large modern plant. Clean, dustless, resilient, durable.

ALL have paved substantial yardages of their streets with resilient, heavy-duty Texaco Asphalt. Let's look at these 1,500 cities for a moment:

★ Heading the list is New York City, which has paved more than 5,000,000 square yards of streets with Texaco.

★ Included among the 1,500 are four out of every five of the largest cities east of the Rockies (25,000 population or over).

★ More than 500,000 square yards of Texaco have been laid by dozens of cities throughout the United States.

This service record, plus the fact that American cities have been paving with Texaco Asphalt for 40 years, are pretty sound reasons for also paving driveways, streets, parking areas, etc. with durable, economical Texaco.

Texaco Engineers, who are Asphalt Specialists, will be glad to discuss paving and maintenance problems with you. Write nearest office.

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